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AN IMPROVED METHOD OF DETERMINING THE SPREAD FACTOR OF WATER DROPLETS [1]

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It is necessary to know the degree of atomization of the spray fluid to achieve adequate spray coverage and distribution. Methods for measuring spray droplet size distributions are essential for studies of pesticide effectiveness. One method for measuring spray droplet size distributions uses a photographic negative of the spots formed when spray droplets are deposited on the surface of a special paper.

To relate spot size to droplet size, it is necessary to know the amount a droplet spreads when it is deposited on the surface of the paper. The spread is usually expressed as a spread factor defined as the ratio of spot size to droplet size. The spread factor is influenced by the surface tension of the fluid, characteristics of the deposit medium, relative humidity of the ambient air, and other factors.

The method described here was used for measurements of water droplets of the sizes commonly produced by agricultural nozzles.[3] Droplet diameters ranged from 50 to 1,000 microns. Preliminary investigations showed that the spread factor was not always constant over this range of droplet size, even for a given fluid and deposit medium. Thus, it was necessary to determine the spread factor for several droplet sizes.

Uniform droplets are necessary for spread-factor determinations. Some investigators [4, 5] used a vibrating member to cause a modulation in the fluid region where the droplets were formed. Other investigators[6] used a rotary device to produce the modulations.

Atkinson and Miller[7] reported that a very inexpensive and convenient droplet-forming device can be made from an electrically operated pump manufactured by Faller[8] in Germany and imported by Edmund Scientific Co., Barrington, N.J. One of these pumps was purchased for ARS

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[3] Bode, L. E. An Evaluation of Spray Deposits From Low Volume Nozzles. 1967. [Unpublished master's thesis, Dept. Agr. Engin., Univ. Mo.]

[4] Davis, J. M. A Vibratory Apparatus for Producing Drops of Uniform Size. U.S. Bur. Ent. and Plant Quarantine ET-295. April 1951.

[5] Mason, B. J., Jayaratne, O. W., and Woods, J. D. An improved Vibrating Capillary Device for Producing Uniform Water Droplets of 15 to 500 Micron Radius. Jour. Sci. Instruments 40: 247-249. 1963.

[6] Rayner, A. C., and Haliburton, W. Rotary Device for Producing a Stream of Uniform Drops. Rev. Sci. Instruments 26(12): 1124-1126. 1955.

[7] Atkinson, W. R., and Miller, A. H. Versatile Technique for the Production of Uniform Drops at a Constant Rate and Ejection Velocity. Rev. Sci. Instruments 36(6): 846. 1965.

[8] Trade names and names of firms are used in this publication solely for the purpose of providing specific information. Mention of a trade name or a firm does not constitute a guarantee or warranty of the product or firm by the U.S. Department of Agriculture or an endorsement by the Department over other products or firms not mentioned.

use. This pump, when inserted in the fluid line, produces modulations in the fluid, which causes uniform droplets to form at an orifice at the end of the line.

Figure 1 shows a block diagram of the electrical and liquid flow path for the apparatus that was used. A precision air pressure control regulator was used to pressurize the air above a reservoir of fluid. The air forced the fluid through the pump where an electric magnet vibrated the liquid. The amplitude and frequency of the vibrations was controlled through an audio oscillator and an alternating-current amplifier. The amplifier was used since the output of the oscillator was not of sufficient amplitude to drive the pump unit. The droplet size could be regulated by changing the frequency or amplitude of the electrical signal to the pump. A stainless steel hypodermic needle was fitted to one end of the electric pump to serve as an orifice. The pump was fastened in a clamp and supported so that the droplets would fall into a special collection cell where size measurements could be made. Figure 2 shows the droplet-producing apparatus.

The collection cell for determining the droplet size was constructed from a Plexiglass material and filled with two immiscible oils. A heavier oil, pump oil, was placed in the cell first;

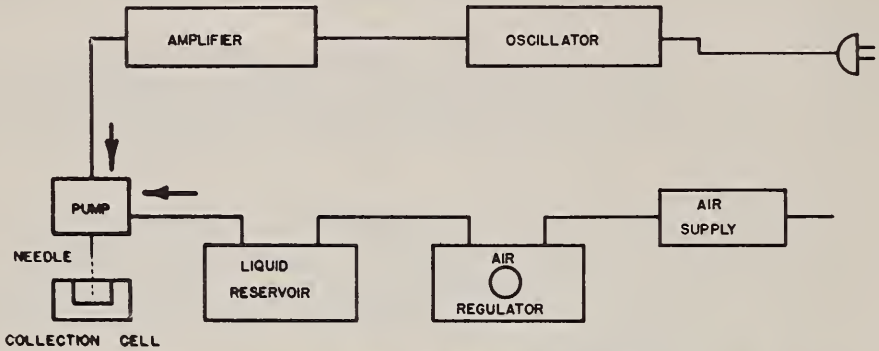

Figure 1.--Block diagram of electrical and liquid flow path.

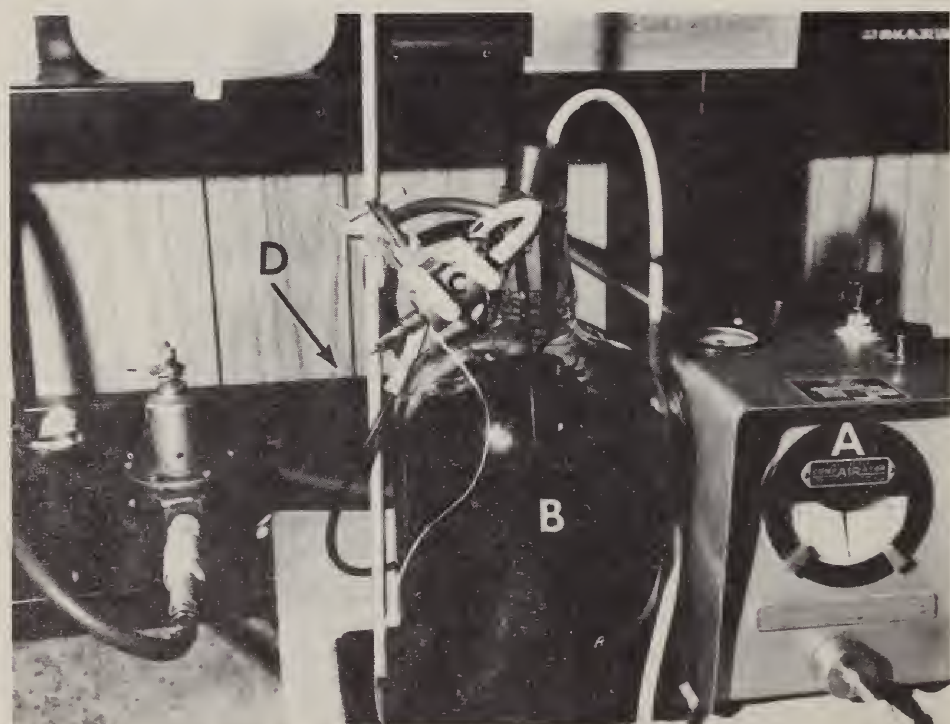

Figure 2.--Close-up view of precision regulator (A), fluid reservoir (B), and pump (C) with hypodermic needle (D).

and then a lighter oil, kerosene, was placed on top. The water droplets remained at the interface of the two oils rather than settling to the bottom of the cell where they would have flattened out.

Lusterkote and Scotchprint paper cards have both been used for determining the spot size.[9] Carmine red dye at the rate of 2,000 p.p.m. was mixed with the water so that good contrast could be achieved with the paper.[9]

The best results were obtained when the input to the pump was 24 volts. The frequency was adjusted for optimum results with each flow rate and needle size. A No. 26 needle and a frequency of 760 c.p.s. produced 500-micron droplets; a No. 27 needle at 1,100 c.p.s. produced 300-micron droplets; a No. 23 needle and a frequency of 260 c.p.s. produced 1,000-micron droplets. Droplets smaller than 200 to 300 microns could be pulled from the main liquid stream by static electricity. In this manner small 30- to 50-micron droplets could be produced.

For the determination of spread factors, spot size must be compared to droplet size. The system was adjusted to produce droplets of the desired size. These droplets were caught both in the collection cell and on the cards. The size of droplet was measured by use of a microscope with a calibrated scale. Samples were also caught on Lusterkote or Scotchprint paper, and the diameter of the spot was measured with the microscope. The spread factor was calculated by dividing the spot size by the droplet size.

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[9] Lusterkote paper is manufactured by the S. D. Warren Co., Boston, Mass. Scotchprint paper is manufactured by the Minnesota Mining and Manufacturing Co. of St. Paul, Minn. Pontacyl Carmine 2B dye is manufactured by Du-Pont De Nemours and Co., Wilmington, Del.

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